



WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005MO53B

Title: Fate and Transport of Heavy Metals in Artificial Soil

Project Type: Research

Focus Categories: Geochemical Processes, Models, Solute Transport

Keywords: artificial soil, soil profile, metal sorption, heavy metal transport

Start Date: 03/01/2005

End Date: 02/28/2006

Federal Funds: \$19,410

Non-Federal Matching Funds: \$43,501

Congressional District: 9th

Principal Investigators:

William J. Likos

John J. Bowders

R. David Hammer

Abstract

ABSTRACT

An innovative waste disposal strategy using “artificial soil” as a final cover system was implemented approximately two years ago at a cement manufacturing plant in Hannibal, Missouri. Artificial soil is a unique combination and layering of organic and mineral materials with no prior measurements of its engineering behavior, long-term physical and chemical stability, or metal immobilization characteristics. The products of weathering and their solubilities and fates in the environment remain unknown. The general objective of this research is to assess the short- and long-term transport of heavy metals in an artificial soil system formed by blending yard waste, sewage sludge, cement kiln dust, and coal ash. Specific objectives include: (1) conduct a forensic analysis of the Hannibal artificial soil layer at locations representing various stages of development (age) to quantify the rate of soil profile development (horizonation) and to predict the long-term (equilibrium) soil profile, (2) implement an in-situ water quality monitoring program to

track mobile metal concentrations in a representative “young” profile and a representative “mature” profile, and (3) quantify the metal sorption characteristics of specific artificial soil layers through a series of laboratory batch-sorption experiments. Results will be analyzed in light of additional results currently being obtained from an on-going research project designed to examine the more general hydrologic behavior of the system, thus allowing us to model and assess the long-term effectiveness of artificial soil as a barrier to heavy metals transport. The project involves significant interdisciplinary collaboration from researchers in soil science, geotechnical engineering, and geo-environmental engineering as well as collaboration with an industrial partner. One graduate student and two undergraduate students will be directly involved in the work. The research will provide quantitative evidence necessary to support widespread use of “artificial soil” as an alternative solid waste disposal strategy and directly addresses the quality of surface and groundwater in Missouri. The research will also provide preliminary data to support future collaborative proposals to the NSF, USDA, and EPA.

FATE AND TRANSPORT OF HEAVY METALS IN ARTIFICIAL SOIL

William J. Likos, John J. Bowders & R.. David Hammer
University of Missouri-Columbia, Department of Civil and Environmental Engineering

Nature, Scope and Objectives

An innovative waste disposal and land reclamation strategy using “artificial soil” as a final cover system was implemented approximately two years ago at a cement manufacturing plant in Hannibal, Missouri. The process, which currently remains in the pilot stage, involves blending and placement of recycled organic and mineral waste materials obtained from various communities and industries located throughout the region. As illustrated in Figure 1, municipal yard waste and sewage sludge are placed as an organics-rich “O-horizon” overlying a mineral-rich “C-horizon” consisting of power plant (coal) ash and cement kiln dust (a cement manufacturing by-product), thus forming a stratified sequence that simulates a natural residual soil column. The “artificial soil” layer is placed over a cement kiln dust (CKD) waste pile and then seeded with native grass and tree species to begin the biological processes associated with naturally occurring Missouri soils. The layer is intended to be an evapo-transpirative barrier to limit percolation through the system, thus, as required by local regulations, preventing subsequent leaching of metals from the various waste materials and the underlying CKD into the groundwater. During 2003, approximately 76,000 tons of unwanted materials were blended, composted, and placed as artificial soil (Table 1). A waste pile nearly four acres in size has now been covered and seeded (Figure 2), resulting in the complete reclamation of a spent limestone mining quarry. The age of the existing cover system ranges from two years to two weeks.